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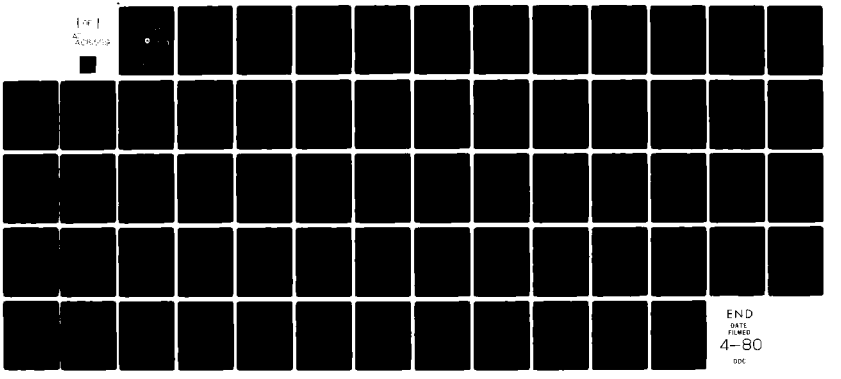

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ADEQUACY OF AIRPORT INVENTORY FOR FUTURE REQUIREMENTS

NATIONAL INSTITUTE FOR COMMUNITY DEVELOPMENT, INC.

APRIL 1979

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Systems Research & Development Service
Washington, D.C. 20590

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16. Abstract

The general objective of the study is to provide the FAA with tools that airport management and planning organizations can use for the assessment of inventory for future requirements. The contract effort is focused on air carrier operations in large metropolitan areas.

An analysis of relevant literature is presented which identifies techniques for planning and forecasting, facility assessment and regional planning. A general regional assessment model is developed which recognizes analytical, organizational and political dimensions.

Principal findings include:

(1) An extensive and comprehensive literature exists, dealing with limited components of the problem such as airside and terminal operations,

(2) No regional assessment technique can be identified that is in operational use,

(3) An assessment process, modified from the work of R.D. Shinn, is suggested.

The process includes: facility inventory; activity forecasting; determination of gaps between inventory and need; identification of alternatives to meet need; evaluation; and, decisions and operations.

An annotated bibliography is included.

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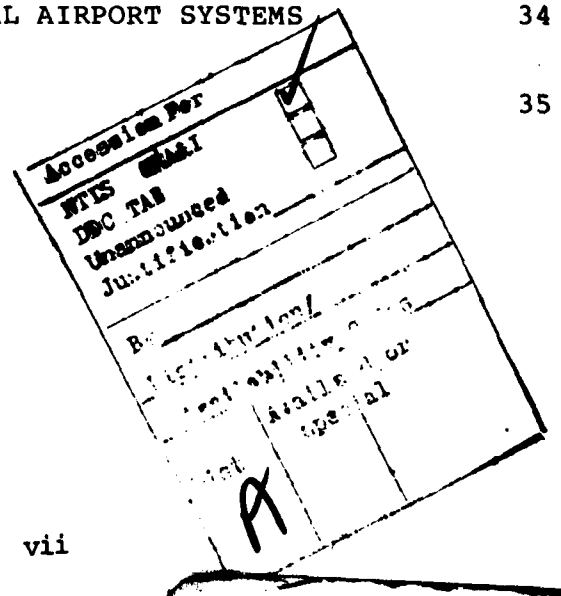

I. INTRODUCTION

A. OBJECTIVES OF THE STUDY

The charter of the Federal Aviation Administration (FAA), spelled out in the Federal Aviation Act of 1958 (as amended), specifies two objectives for the FAA that relate to this study:

- to develop and operate a common system of air navigation and traffic control for civil and military aviation, and
- to assist in the development of an effective national airport system.

These objectives directly affect FAA's policy with regard to the public and private investment in the nation's metropolitan areas to improve the effective use of aviation facilities by the aviation community. This study focuses on assessment of the factors associated with the determination of the Adequacy of Airport Inventory for Future Requirements. The statement of work for this study identifies four objectives (which can be viewed as study steps or phases):

- identify classes of inventory and typical airport facilities for major metropolitan areas;
- identify the types of users and rates of use associated with inventory and facilities by type;
- identify alternative methods to minimize inventory requirements;
- develop a definition of adequacy and various measures to permit a quantifiable evaluation of airport facilities requirements.

The overall objective of the study, towards which these four steps lead, is to provide the FAA with management "tools" that can be used to assess the adequacy of airport inventory and facilities for typical large metropolitan areas.

It became increasingly clear, as the study progressed, that the four steps could not be fully addressed without introducing a framework or developing an understanding of how the components come together for regional

airport operations. Thus, the efforts accomplished, discussed in the balance of this report, have determined the feasibility of and laid the groundwork for more detailed determinations of facilities' adequacy.

It is necessary to specify implied assumptions which emerge during the course of any study that clarify or limit the analysis. The NICD, during an extensive review of the literature (see Chapter II, Section A, Background), has identified certain assumptions which are necessary to help focus the stated objective.

B. STUDY ASSUMPTIONS

To help delimit the scope for this study, several assumptions are made:

- the analysis focuses on methods of major hub metropolitan airport system assessment;
- the future requirements for aviation demand are based upon existing FAA forecasts which identify, within "scenario ranges", the activity levels expected for the next twelve-year period;
- methods for prescribing the development of new air carrier airports will not be considered;
- the development of solutions for air navigation and traffic control within the context of facilities used to control aviation between metropolitan areas will not be considered.

C. TECHNICAL APPROACH

The development of the assessment process is patterned after the seven-step technique of Structured Systems Design (SSD), developed by Langston-Kitch Associates.[1/] Although generally used to design and

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1/ SSD is being used by various groups of the FAA. An appendix has been included to provide an overview of the SSD approach.

develop computer systems and plan their implementation, SSD is valuable to the definition and design of an assessment process by providing a means for verifying the need for an assessment process, obtaining agreement on the purpose of such a process, definition of the functions of the process, and design of a framework for conducting regional assessment of airport adequacy. Since this project is limited to development of a framework for an assessment process, the elements of SSD that are most relevant are the first three (of the seven normal steps of SSD), as described below:

- Planning - an extensive amount of work has been done and studies available on airport capacity, master planning, access, facilities investment, scheduling and demand forecasting analysis. In the first phase of the SSD process the need for the proposed process is verified and the environment within which it would be used is identified. This is substantiated in Chapter II, Section A, by a review of the legislative history and literature concerning the accomplishments in planning and forecasting, facility inventorying and regional planning.

- Requirements Analysis - Chapter II, Sections B through D, present conclusions drawn from the review of available literature and provides an initial concept of how the proposed process should be structured, the dimensions of the process, and the proposed Federal role in assessment. Chapter III, System Interrelationships, provides details regarding the existing mission, functions and decisions made by the organizations that should participate in the assessment process.

- Design - Chapter IV, Regional Assessment Process, describes the key steps of the airport assessment process proposed for metropolitan airport systems.

Four more steps (construction, installation, operations and use) remain in SSD. However, it is apparent that the assessment process, at its present level of generality, requires additional detailed evaluation, perhaps by case study applications. Therefore, Chapter V, A Framework for Implementation, is provided to suggest activities that will provide the testing, application and computer design necessary to achieve the full-blown, operational process.

D. SUMMARY FINDINGS AND OBSERVATIONS

1. Inventory and Facilities Assessment

An extensive and comprehensive literature exists, dealing heavily with airside and terminal operations. Considerable detail is available with respect to component capacity determinations and control and management of the airside component. A number of alternative predictive and evaluative models are discussed in the literature.

With respect to the landside and interface among the three components (i.e., airside, terminal, and landside) additional work appears necessary, particularly to begin to specify the relationships between access factors, and terminal and airside capacities.

It therefore appears that the FAA, as an organization, has more technical and engineering knowledge about airport facilities and capacities than can be easily assimilated to support inventory adequacy assessment. The documentation is rich; needed are major syntheses of the varied and comprehensive technological and model information, to focus on generalization and the identification of "gaps" (i.e., capacities insufficient to satisfy forecast needs).

2. Regional or Metropolitan Area Adequacy Assessment

No technique is now operationally in use for regional or metropolitan area assessment of inventory adequacy to meet future needs, according to the literature reviewed and interviews conducted for this report. Additionally, the role of the FAA is constrained by the pluralistic nature of the domestic air carrier airport "system" and by the legislative authority granted the FAA. Particularly, the FAA has some authority to influence planning through its control of certain funds, but that authority is limited by the political decisions with respect to Congressional authorizations and appropriations. Principal roles for the FAA in the assessment process lie in the organizational, solicitation, and guidance arenas rather than in the directive arena.

Also, adequacy assessment involves more than technical problems. There are multi-dimensional considerations in assessment involving political,

organizational and sociological factors, in addition to the relatively easily determinable factors of costs, technological capabilities, and effectiveness.

The NICD study concludes that a useful but highly general regional/metropolitan area assessment model (derived from the planning model of Shinn[1/] and presented in detail in the body of this report) can be developed for near-term (i.e., up to two year) durations, and consists of the following major steps:

- inventory of facilities
- activity forecasting for up to two-years hence
- analysis to determine gaps or differences between facilities inventory and forecast need
- identification of alternatives to meet forecast need
- evaluation
- decisions and operations

The assessment process necessitates recognition of three dimensions:

- analytical
- organizational
- political

with a clear understanding of responsibilities and roles for the organizational participants, (i.e., regional and community planners, airport and airline managers, local and regional governments, other transportation authorities, and the FAA).

To summarize, the NICD has developed the basic conceptual framework of what might later become a full-fledged operational system for assessment of airport adequacy in a regional/metropolitan area.

1/ Regional Airport Planning: A Systematic Model, Richard D. Shinn, University of Wisconsin, 1970.

This report is designed as an informational document that is recommended for distribution only to persons within the FAA.

This paper leaves undefined for the moment precisely how the assessment process can be refined, tested and implemented. However, some generalized next steps are suggested immediately as follows. In order to stimulate further discussion among the aviation planning community an executive summary or "issues paper" should be prepared, based upon this document, for distribution to metropolitan planning organizations, and airport and airline planning officials. After the aviation planning community reviews the "issues paper", an action plan should be constructed to involve some of the planning organizations and planners in testing the acceptability and potential usefulness of the process as a planning and management tool. Chapter V of this report, A Framework for Implementation, provides some guidance for such future efforts.

II. STATE OF KNOWLEDGE ABOUT INVENTORY ASSESSMENT

A. LEGISLATIVE HISTORY AND LITERATURE REVIEW

This section reviews the relevant highlights of the research and analysis found in reports, regulations, and other documents concerning airport inventory assessment and its relationship to metropolitan areas. The review covers three major areas: (1) planning and forecasting, (2) facility assessment and (3) regional planning.

1. Aviation Planning and Forecasting Techniques

Aviation planning and forecasting is seen to have a direct influence on inventory assessment. There must be some predictions of future aviation demand to provide the standards against which inventory can be assessed. A review of both public and private (the airline industry) techniques is necessary since both constituencies have critical roles in the management of aviation facilities.

National Airport System Plan (NASP) - The largest public effort, carried out by a single mandate is the NASP which is mandated by the 1970 ADAP legislation. That law requires the Secretary of USDOT to develop airport needs, annually updated, for the next decade.[1/]

The first plan, developed by the FAA, covered the 1973-1982 period and recommended a development expenditure of nearly $7 billion to meet the estimated need for 707 new airports (60 of which would be air carrier).[2/]

Since the current format of the NASP specifies funding for projects related to airports, the plan has become predominantly a list of "locally identified projects which pass certain minimal tests

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1/ Prior to the 1970 legislation, the FAA produced a five-year NASP, which was also updated annually.

2/ This ten-year plan is not to be confused with another less formal activity, carried out by the FAA, referred to as the National Aviation Systems Plan. This was issued in 1975, and concerned the FAA's role in the ensuing ten years regarding aeronautical services. Thus, the plan deals with specific FAA services rather than airport facilities.

concerning their suitability for airports of a particular size", according to deNeufville.[1/]

A more important element of the FAA's role in fostering domestic aviation seems to be those issues concerning forecasting and "futures" activity, both important elements of the agency's overall technical planning efforts.

Activity Forecasting - The FAA, to support the development of the NASP and to meet other technical planning needs, has an extensive forecasting effort. Concerned with all aspects of aviation activity, the forecasts, covering a twelve-year period, consist of annual estimates of future national operations, passengers, cargo, fleet size and revenues. The national estimates are then used to develop localized estimates at terminal control areas (1000 airports), large hubs (97 airports), air route traffic control centers (25), and flight service stations (326).

Since this present study is concerned with regional airport inventories and facilities, the terminal and large hub forecasts are most relevant. It is noted that although these forecasts provide valuable insight about future needs of the nation regarding aviation, their aggregate development procedure obscures several issues that directly influence the analysis at the local level. Although carefully developed national economic factors and trends are used, local and regional variations from national estimates are a constant source of difficulty in the "top-down" approach.[2/]

"Futures" Activity - An important element of any forecast method is its ability to have the flexibility that allows for simple revisions based on updated information. Carefully documented in a recent FAA summary report, the "futures" work has

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1/ Airport Systems Planning, Richard deNeufville, The MIT Press, Cambridge, MA, 1976, p. 18.

2/ A detailed discussion of improvements to regional forecasting is contained in FAA Aviation Forecasts Fiscal Years 1979-1990, Chapter 4, which outlines the "outreach" program currently underway for local forecasts.

used a longer time period than the activity forecasts and identified five scenarios that produce variations in the estimates for the nation.[1/]

An important aspect, as pointed out by deNeufville, with respect to airport systems planning at the regional level, is the balancing of the likely error in forecasts through the use of alternative scenarios. More importantly, simple techniques that do not overwhelm the analyst and political decision maker are necessary. As an alternative to using trends or statistical forecasting, deNeufville suggests that technological forecasts be used for airport planning.[2/]

To an extent, futures work takes possible technological changes into account, but does not prejudge which one is most likely to occur. In a 1976 study by USDOT,[3/] an extensive technology assessment for all inter-city travel modes was completed and provides useful insight regarding potential impacts. This analysis used four scenarios of national trend alternatives in developing various estimates of inter-city travel and the modes likely to be used. Exhibit II-1 highlights the recommendations of this most recent effort.

2. Analysis of Airport Facilities

Any review of the current state-of-the art for airport facilities analysis, particularly with respect to capacity analysis, is risky. So much research has been completed in recent years that any discussion, comparison of techniques, or evaluation of results requires substantial resources. This section provides only an overview of some of the most recent work and is divided into discussion of: airside, landside, system interfaces (i.e., airside and landside), and some off-airport issues.

1/ Aviation Futures - To The Year 2000, USDOT, FAA, February 1977. This document was issued to attract general comments. The more detailed back-up technical reports are to be released by the FAA in the near future.

2/ deNeufville, Op. cit. pp. 43-44.

3/ Technology Assessment of Future Inter-City Passenger Transportation Systems, USDOT-NASA, March 1976.

Airside Facilities - The basic measures of airside capacity as used in design is perhaps best documented in the FAA document, Airport Capacity Criteria[1], which identifies methods for determining runways, taxiways and apron configurations. Most of the techniques outlined in the document do not need further clarification. The most important element of the analysis is the runway takeoff and landing capacity, and recent efforts to examine upgraded air traffic control systems will probably have an important affect on the capacity. An analysis of the proposed upgraded system's impact at 30 major airports led to the conclusion that delay reduction benefits would exceed system costs by nearly fourfold.[2] The cited report does serve current management needs at the regional level, since the forecasted delays are based on input figures from the national scenario assumed for the study in the year 2000.

The study of the upgraded ATC system also includes an impact analysis of related policy actions which could affect baseline assumptions. Those which affect airports and their regions include: price or quota redistribution of airport usage that could affect time patterns; increased numbers of satellite terminals or secondary airports; and increasing size and number of Terminal Control Areas (TCA's).[3]

Two techniques are potential management options for facility assessment. A review of the options would be useful. The techniques are discussed in AVP-77-5 and 77-12, Theory and Practice and Network Impacts, respectively. These two reports do not conform to the deNeufville principle of simplicity in systems development and cannot be thoroughly explained in this brief background statement. But the process whereby individual airport regions would develop constraints (on schedules or quotas) independently of one another is unrealistic.

1/ USDOT-FAA Advisory Circular 150/5060-1A, 8 July 1968.

2/ Policy Analysis of the Upgraded Third Generation ATC System, William R. Fromme, et al. Final Report, USDOT, FAA-AVP-77-3, January 1977.

3/ Since this last activity would be under the direct control of FAA procedures, it was not considered a candidate for the local assessment process in the regional planning framework.

The integrated national scenario for examining such control policies, as with the network flow schedule simulator, will most likely continue.[1]

Landside Facilities - The capacity and delay studies for these facilities have taken a somewhat different approach. Since landside facilities affect those activities not associated with aircraft, the analysis does not get directly involved with inter-airport networks. Given a specified number of passengers[2] to be processed within the landside facilities, most of the activity planning can be accomplished without knowledge with respect to where they are going or to which airplane they will embark (or from which airplane they will debark).

FAA-78-2, Landside Models, a recent analytical study was designed to develop techniques to measure facility capacity and delay for landside operations of an airport.[3] The report documents a serious attempt (historically, the second) to develop what is referred to as a "level III" model which incorporates steady-state queuing analysis where, for given periods of time, random fluctuations from average rates of demand and service are described

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1/ A third document, The Airport Network Flow Simulator, available as a draft document in September 1977, complements the two studies. The basic parameters of capacity and delay, as determined by the ANFS, are identifiers for 24 airports in the test network. The simulator can be run on any set of 24 airports selected by the user and will account for any portion or all traffic at all of the nation's 656 airports in the demand file as of 1974. (Note: Obviously, if one airport is selected, only a small percentage of the total demand is required.)

2/ The reference to "passengers" throughout implies that cargo has been ignored. This is the case for the FAA studies reviewed; no attempt was made to examine cargo terminal design models. It is taken on faith that they do exist and must be incorporated when appropriate to the process.

3/ The FAA's Airport Landside Model - Analytical Approach to Delay Analysis, USDOT-FAA AVP-78-2, January 1978 by H.H. Aerospace Design Co., Inc.

by a probabilistic process.[1/] The analysis represents the entire landside system and describes detailed networks for two major subsystems: terminal and groundside.[2/] Exhibits II-2, and II-3 summarize the components and major input and output measures used for the two systems. The explicit assumptions developed for this modelling concept are dependent only on the model user's assumptions with one exception--the airside demand profile. However, the model is constructed so that any hourly enplanement demand pattern can be input to the model, rather than depending on historical patterns and default "profiles" developed by FAA statistics.

Interface of Airside/Landside - One of the more persistent analytical problems not addressed carefully in the literature is the interface between the two classes of facilities. Obviously, the point at which the two systems physically interact could best be described as the "passenger lounge at the gate," but any observer of airport terminal operations knows that scheduling disruptions and the distribution of information about the schedule affects the landside system at many, if not all, of its components.

One detailed attempt to examine the interrelationship was developed as the Airport Performance

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1/ The level IV Model, currently considered beyond the scope of realistic attainability, consists of demand arrival and service rates that are 1) probabilistic and 2) time-varying (rates can be a function of time). This is the type of model used to simulate flight schedules in the airside evaluation. Since the number of passengers is approximately 100 times the number of flights and the individual functions within the terminal significantly larger than that, one can understand the difficulty with "discrete event" simulation of terminal passenger activity.

2/ A better term for "groundside" might be vehicle access subsystem, since all aspects of nonpedestrian access to the terminal (airplanes excepted) constitute this component.

EXHIBIT II-2

AIRPORT GROUNDSIDE INVENTORY AND ACTIVITY PARAMETER COMPONENTS

Major Component	Subcomponents	Major Parameters
Roadway	-	I Number of Lanes A Average Speed I Intersections A Vehicle Mix A Passengers per Vehicle I Length of Roadway
Parking	Long Term	I Spaces Available A Average Length of Stay in Lot
	Short Term	I Spaces Available A Average Length of Stay in Lot
	Rental Car	I Number of Servers A Service Time, Discipline A Transportation Mode to Terminal
Curbside (vehicle)	Enplaning	I Curb Length I Number of Terminal Doors I Number of Lanes A Vehicle Mix A Passenger/Visitor Ratio A Number of Bags/Passenger I Share with Deplaning (Yes/No) A Passenger Per Vehicle Type
	Deplaning	I Curb Length I Number of Terminal Doors I Number of Lanes A Vehicle Mix A Passenger/Visitor Ratio A Number of Bags/Passenger I Share with Enplaning (Yes/No) A Passenger Per Vehicle Type

I - Inventory components
A - Activity parameter statistics

Source: FAA-AVP-78-2, The FAA's Airport Landside Model pp. 2-5

EXHIBIT II-3

AIRPORT TERMINAL INVENTORY AND ACTIVITY PARAMETER COMPONENTS

Major Component	Subcomponents	Major Parameters
Curbside (passenger)	-	I Enplaning/Deplaning Separate (Yes/No) I Number of Doors A Bags/Passenger
Ticketing	Full Service Information Only Baggage Check-In Seat Assignment	I Number of Servers A Service Time/Discipline A Number of Bags A Service Used I Skycaps, Assistants (Yes/No)
Security	-	I Manual or X-Ray A Carry-on Bags/Passenger I Series Servers (Yes/No) I Number of Servers A Passenger/Visitor Ratio
Seat Assignment	Boarding Pass Seating Assignment	I Number of Check-In Servers I Geometry
Baggage Claim	-	I Equipment Type/Capacity A Bags/Passenger I Number of Units I Positive Claim (Yes/No) I Distance from Arrival Gate
Federal Inspection	Customs Health Immigration	I Number of Servers A Bags/Passenger A Service Time Discipline A Series Servers (Yes/No)
Rental Car	-	I Number of Servers A Reserved Car (Percent) I Manual/Machine I Transportation Type to Ready Car/ A Drop-off Area

I - Inventory components
A - Activity parameter statistics

Source: FAA-AVP-78-2, The FAA's Airport Landside Model pp. 2-6

Model (APM).[1/] However, this model does not represent the behavior of individuals when they receive information about schedule changes.

Satellite and Off-airport Facilities - A third component alternative which may directly affect regional facilities assessment and, more importantly, may be an option which local authorities could control more directly, are satellite and off-airport facilities. This option, with respect to increasingly greater runway service rates, is discussed in the FAA's technical reports concerning airside capacity alternatives, but is not specifically dealt with by the landside models.[2/]

The issue of whether analytic models must deal with the air trip in a door-to-door sense has been a continuing problem. Metropolitan planning agencies, faced more directly with this issue than with that of aviation facilities assessment, have conducted numerous access studies and examined alternatives for improving regional planning techniques to solve this problem. deNeufville stresses the access problem through an entire chapter in his book and concludes that the emphasis on the value

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1/ The Airport Performance Model - Extensions, Validation and Application, undated draft report SS-213-U4-415, prepared by Bellantoni, et al. The report documents the simulation of both groundside and landside operations for 31 separate airports. The model, of course, does not satisfy the needs of multiple airport hubs, and requires schedules as input.

2/ Since the landside models generally deal with vehicles within the airport property, separate models could be developed of off-airport processing facilities. However, the transfer of either passengers or flights to these new facilities is a very complex question. Additionally, with respect to unscheduled operations and more particularly, General Aviation, many issues with regard to this component of aviation have not been adequately examined in the literature. See Chapter V for additional discussion on this matter.

of time that air travelers perceive (or are estimated to perceive) has been disproportionate to the time actually saved and has resulted in suggestions for high capital cost access solutions.[1/]

The access issue in itself has some relationship to options of additional satellite and off-airport facilities that would provide greater accessibility to the region's air passenger and cargo origins and destinations. In a 1970 study of the Washington-Baltimore region the discussion of access was based on existing origins and destinations and a revised allocation of flights in the Washington area's airports, and used travel time costs of various users to measure disadvantages.[2/] Since the earlier efforts, various aviation system planning efforts carried out by regional and state planning agencies continue to emphasize the implications of the origins and destinations of air travelers in the regional assessment and planning process.[3/]

With respect to other off-airport issues the matter of the airport and its overall relationship to the region involves more than travel time factors. In a presentation to a TRB Conference, Paullin listed six functions that impact landside capacity and that relate to off-airport facilities: 1) access, 2) parking (off-airport), 3) off-airport terminals, 4) urban development (land-use) pattern, 5) multiple jurisdictional responsibility, and

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1/ deNeufville's focus is obviously a result of his considerable urban planning experience and background. He has co-authored several major works on airport access.

2/ Technology and Decisions in Airport Access Robert F. Baker, et al., ASCE Special Report, 1970. The document uses 1967 origins and destinations data to measure variations in ground travel time from forecasted 1990 origins and destinations.

3/ See, for example, Future of Washington's Airports, Washington Metropolitan Council of Governments, 1975 and Maryland Aviation System Study, Maryland DOT, 1974 for additional issues and techniques for access to three regional airports.

6) financial resources (of local/federal government and the local economy).[1]

As the 1970's have emerged, increased attention has been given to off-airport community impact, both in terms of benefits and disadvantages. Numerous studies, climaxed by the most recent USDOT study, have attempted to define the environmental relationship of the airport to its neighbors.[2] A study of improved facilities assessment should, therefore, recognize this issue.[3]

3. Regional Coordination and Planning Efforts

The Advisory Commission on Intergovernmental Relations (ACIR) is one of the most effective Federal agencies analyzing public coordination of local and state government activities, and their relationship to national planning initiatives. An ACIR document on transportation planning, published in 1974, provides a comprehensive review of metropolitan organizational structures.[4] The focus of this report was primarily "regional transportation systems" and was the result of efforts to link the various planning model activities.

In a 1970 report, the FAA provides guidelines for systems planning of airports within the regional context, more commonly referred to as a metropolitan area. This document recognized that regional

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1/ "Influence of Airside and Off-airport Factors on Landside Capacity," Robert L. Paullin, paper presented to TRB Conference, documented in SR159 Washington, D.C. 1975, pp. 189-208.

2/ Handbook for Environmental Assessment of Airports, USDOT, FAA, August 1978, 3 volume series, by Skidman, Owings and Merrill, et al.

3/ The point here is not to set aside community issues, but to emphasize that in the assessment of inventory, its usage and capacity relationships, the issue of noise impact is one which is very difficult to include in an analysis.

4/ Towards More Balanced Transportation: New Intergovernmental Proposals, ACIR Report A-49, December 1974.

planning organizations, as they currently exist, were the most likely to achieve comprehensive planning and to integrate more detailed functional planning efforts (airports, highways, mass transit, land-use, etc.) for each of the specific urban transportation subsystems.[1/]

However, aviation planning is not usually included with other transportation systems by regional planning organizations. This is demonstrated by the fact that of 81 planning regions reporting, only 14 (about 17 percent) cited aviation as one of the "comprehensive" modes within the planning requirements. The fraction increases to 33 percent of the most populous regions reporting (over one million) (see Exhibit II-4). Concurrently, the increase in multi-mode state DOT's has resulted in some increased activity in aviation planning at this level.[2/]

Aviation Community Planning Scenario - Within the context of aviation planning at the regional level, the most extensive works include Shinn (1970)[3/] and deNeufville (1976).[4/] These efforts attempt to examine the problems and potentials of regions in administering both planning and operation of airport facilities. Exhibit II-5 illustrates five basic assumptions made by Shinn. The apparent influence of his work resulted in an extensive elaboration of a systematic model. It is within this context of the work completed by Shinn that the proposed assessment process is further discussed.

1/ Planning the Metropolitan Airport System, USDOT, FAA, May 1970, prepared by Airports Service Group p. 7.

2/ The impetus of ADAP fostered both state and regional systems efforts. See Section IV for additional discussion on airport systems planning.

3/ Regional Airport Planning: A Systematic Model, Richard D. Shinn, University of Wisconsin, 1970.

4/ Airport Systems Planning, Richard deNeufville, The MIT Press, Cambridge, MA, 1976.

EXHIBIT II-4

SUMMARY OF COMPREHENSIVE PLANNING AND INCLUSION OF AIR TRANSPORTATION BY REGIONAL AGENCY IN SECTION 134 CERTIFIED* PLANS
OCTOBER 1973

	MODE			
	HIGHWAY	TRANSIT	AIR	TOTAL REPORTING
CHARACTERISTICS OF PLANNING AGENCY'S REGION				
Population				
Over 5 million	3	3	2	3
1 to 5 million	21	19	6	21
Less than 1 million but over 250 thousand	57	26	6	57

Source: USDOT Data Compiled by ACIR. See Table II-27 pp. 108-109 of Balanced Transportation...(A-49)

*Section 134 of Federal Aid to Highways Act of 1962, as amended.

EXHIBIT II-5

POLITICAL ASSUMPTIONS THAT AFFECT REGIONAL AIRPORT PLANNING
Shinn's Model - May 1970

1) FAA will step up its program of airspace control in the vicinity of terminals by establishing more stringent approach and takeoff corridors and separation of traffic based on equipment, speed, number of pilots, etc.

2) State planning agencies in cooperation with state departments of transportation or state aeronautics commissions will make significant advances in programs which prepare plans and provide technical assistance to regional airport planning groups.

3) Councils of governments will be the dominant participant in regional airport planning at the local level over regional, county and/or city planning commissions.

4) Metropolitan airport authorities in special purpose district form will be attempted in several places by way of state legislation and local ballot, but few will survive the process to become the dominant participant in regional airport planning for their particular locales.

5) The weight of regional aviation issues will be so pressing that the disjointed administrative constructs in most metropolitan areas led by COG activities will coalesce by use of agreements in management of a process that includes planning, development and operations.

B. DESIGN APPROACH

As noted, the previous work by Shinn, in 1970, represents a rare attempt to define a regional airport planning process and construct a systems model which describes activities and organizational relationships. This extensive effort, however, arrived primarily at what might be best described as a "procedural concept." In other words, although the complexity of the process was described, its inherent difficulties outlined, and a general structure defined, no detailed analytical procedures were actually developed. Shinn did, however, "test" the concept, through its development, on actual regional planning situations.

It is suggested that a similar process be developed for evaluating the adequacy of regional airport inventories. The intent is to use the ideas of Shinn but modify his approach to emphasize the assessment element of the regional airport system. It is ultimately desirable that assessment be linked to planning and made an integral part of an overall planning and assessment process. The assessment process described herein will be a procedure that facilitates operational policy decisions at the airport or regional management level. The process focuses on assessments of inventory adequacy over a time period of up to two years. The assessments must be updated regularly, in order to ensure continuing utility.

C. DIMENSIONS OF THE PROCESS

To develop an overview of the process, it is necessary to identify the dimensions within which it will operate. The process will include analytical, organizational, and political factors or components. Each dimension has limitations and constraints; these are now reviewed to help create the framework for the more detailed development in Chapter IV.

1. Analytical

This first dimension is the easiest to "define," in the sense that techniques, models and data currently exist to help support the proposed process. In fact, it is most likely that too much information is produced by competing interests, such that conflicting but substantially professional positions emerge from a large variety of analytical outputs.

The analytical elements can be identified by classifying them into two major categories:

Static Procedures	Dynamic Procedures
Inventory of Facilities	Aircraft Demand Forecasts
Airside Capacity	Air Passenger Demand Forecasts
Landside Capacity	Economic Feasibility for Investment
Delay and Quality of Service	Economic Profitability of Operations
	Environmental and Other Community Impact Considerations

Static Procedures - These generally fall into the category of well-defined engineering or statistical measures and formulations, tested over time. Recent developments have resulted in improved dynamic formulation of the models, such that simulation to varying degrees can be used to improve on the static representations. This is especially true with the airside capacity simulation for flight operations. The most recent studies by FAA, as referenced in Chapter II, have also resulted in landside capacity models which for the first time incorporate the delay formulation in terms of queuing theory.

While both the airside and landside capacity procedures output delay formulations and convert them into cost, the perceived "quality of service" has yet to be developed. This issue would be difficult to classify as static measure.

Of course, the classification of these procedures as "static," does not imply that they do not change. Air traffic control and terminal design innovations will result in model changes. The point is that for the existing inventory of facilities, such formulations are generally static.

Dynamic Procedures - These relate more directly to the socially and economically driven elements of aircraft use and passenger demand. These analytical techniques, especially with respect to forecasting, are highly volatile and the construction of alternative scenarios has been one of the most common methods used to define their uncertainty.

One objective of the proposed assessment process is to attempt to minimize the degree of uncertainty that exists by reducing the time frame of the "future."

Potential Improvements - The proposed process, with respect to the analytical dimension, is unlikely to suggest major changes. The vast amount of technical research is too great to be challenged and, secondly, the process will be more successful if it improves the format, content and understanding of the analytical inputs and outputs to facilitate their use, rather than see them relegated to the shelf in thick reports. Procedures, as proposed, should seek to improve the turnaround time for the techniques so that they can become interactive.

Most importantly, the analytical system must be adaptable to changes in assumptions and be one which can solve individual problems without "overwhelming" the user with extensive data inputs, or a requirement that an entire set of models be run at all times. The mathematical formulations must be available to users and, if computers are required, time sharing, low-cost options must be available.

Existing Gaps to be Closed - The most needed analytical procedure, not yet fully developed, concerns the regional hub forecasting algorithm. As noted earlier, the most recent FAA forecasting document proposes the "outreach" program for improving the local adoption of forecasts which are compatible with the national estimate. Following sections of this report contain suggested procedures to facilitate this endeavor; however, it is likely that extensive educational efforts, as previously mentioned, will be required.

Second, the integration of terminal facility planning by the airlines with regards to their analytical techniques probably needs improved coordination. The terminal "landside" capacity model as developed by FAA cannot uniformly meet the requirements of all airline landside operations, but some agreed level of coordination is essential to the process.

Third, and the most serious gap, is the translation of delay and "cost" measures into a quality of service measure. The existing models, as noted,

provide adequate mathematical estimates of cost, but most make certain assumptions regarding the "value" of delay as perceived by the travelers. Other transportation forecasting and assessment techniques have had the same difficulty with the "value of time" function in estimating demand. Any improvement in this area would improve the use of this information in realistic decision making processes.

2. Organizational

It appears that the proposed process can make a contribution towards a better definition of an organizational framework. As with Shinn, although proposals are easy to make, implementation of recommendations are difficult to realize. Therefore, the organizational dimension of the process must develop carefully defined roles and responsibilities. Since it is not within the FAA's role to mandate procedures or structures to any local government, the recommendations must be viewed as suggestions.

A major element of the proposed process is to make planning more adaptable to the management process of an airport or series of airports in a given region. To this extent, it is expected that the owner or operator and daily manager of the airport inventory would be familiar with the planning perspective and, conversely, the planner must be more familiar with operational alternatives.

Second, the contributions of the individual airlines operators will be required in the process. Historically, most airlines reserve planning to a headquarters operation. Local operators become involved in planning only when a special master plan or systems study at an airport is undertaken.

3. Political

A third dimension to any process, involved with community issues, concerns the "political" framework. This recognizes that certain individuals, acting in elected positions or exercising community activist roles will have an increased influence on the process. This activity, in some cases, might be described as over and above the normal "operating or organizational procedure."

This element of the process recognizes that, even in structured systems, the individual characteristics of the region must be accounted for. Many of these characteristics are political and some may be classified as "social." To an extent, the political element of the system also recognizes that perceived market factors have also emerged to account for different social and economic characteristics of air travel in the various hub systems.

D. THE FEDERAL ROLE

The role of a Federal agency, the Federal Aviation Administration, in spurring the development of an improved assessment process, must be examined from the standpoint of the agency's mission and authority. This has evolved as an advisory one, primarily in technical areas. Airport operators, airlines, planning organizations and governmental bodies must understand and implement the process.

Since each airport hub does have a distinct airside systems relationship with many other hubs, FAA's role with respect to operation of the air traffic control system cannot be ignored. Some might view FAA's role in assessment as being the initiator, in terms of setting out policy regarding its implementation. Others might also include, as a role for the FAA, the establishment of a national scheduling policy (in cooperation with the airlines) so that the assessment could be carried out using the same assumptions for scheduling at all hub airports.[1/] Still others might view the FAA as being the actual executor of the assessment process, setting up the process for carrying out the necessary analytical functions, inventorying facilities, making forecasts of needs, and providing the local hub agencies with a set of data for review. In this case, only the organizational and political elements of the process would operate at the metropolitan or regional level.

None of these specific FAA roles would achieve the desired results. A cooperative effort between all planning, commercial and governmental parties must be launched. As a regulator of aviation safety and developer of procedures with regard to flight services, the FAA role would most likely dominate that portion of the

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1/ The impact of deregulation would make this option very difficult to implement at this time.

assessment process that identifies airside delay algorithms and the needs of terminal control systems for aircraft. With respect to schedules, the FAA and CAB role has been significantly reduced and, on the basis of recent legislation, market forces, pricing techniques and the airline industry are beginning to exert increased influence. The FAA role in this area would most likely be one of information facilitation and coordination. Otherwise, it would be difficult for individual airlines to deal in an effective way with regard to schedule policy in any assessment process.

In those aspects of the process that deal with regional landside issues, the FAA role is reduced to one of "general grant authority" in its approval of ADAP development projects. Since most local aviation facilities are assessed by either the owner operator or the commercial lessee, the FAA role in this part of the assessment process must be viewed in terms of providing guidelines and analytical tools for the local agency.

1/ The impact of deregulation would make this option very difficult to implment at this time.

III. REGIONAL ORGANIZATIONAL INTERRELATIONSHIPS

Before developing a detailed description of the proposed process, it is important to discuss the organizational elements most directly affected. Existing activities of the various institutions cannot be dramatically altered nor is that the intention. The only two major organizational areas to be directly impacted by the process are urban planning organizations and airport system management authorities or departments of the local governments. Other areas indirectly impacted include the airport operations (on-site, day-by-day managers), airline terminal and headquarters management staff, aircraft designers and manufacturers, state aviation authorities or regulatory agencies, the airline passengers, and private aircraft and cargo users (and related federal departments and legislative bodies at all levels of government). This chapter reviews the impacts of these "actors" and develops the framework for system interrelationships that must be accounted for in the assessment process.

A. SYSTEM DESIGN STEP

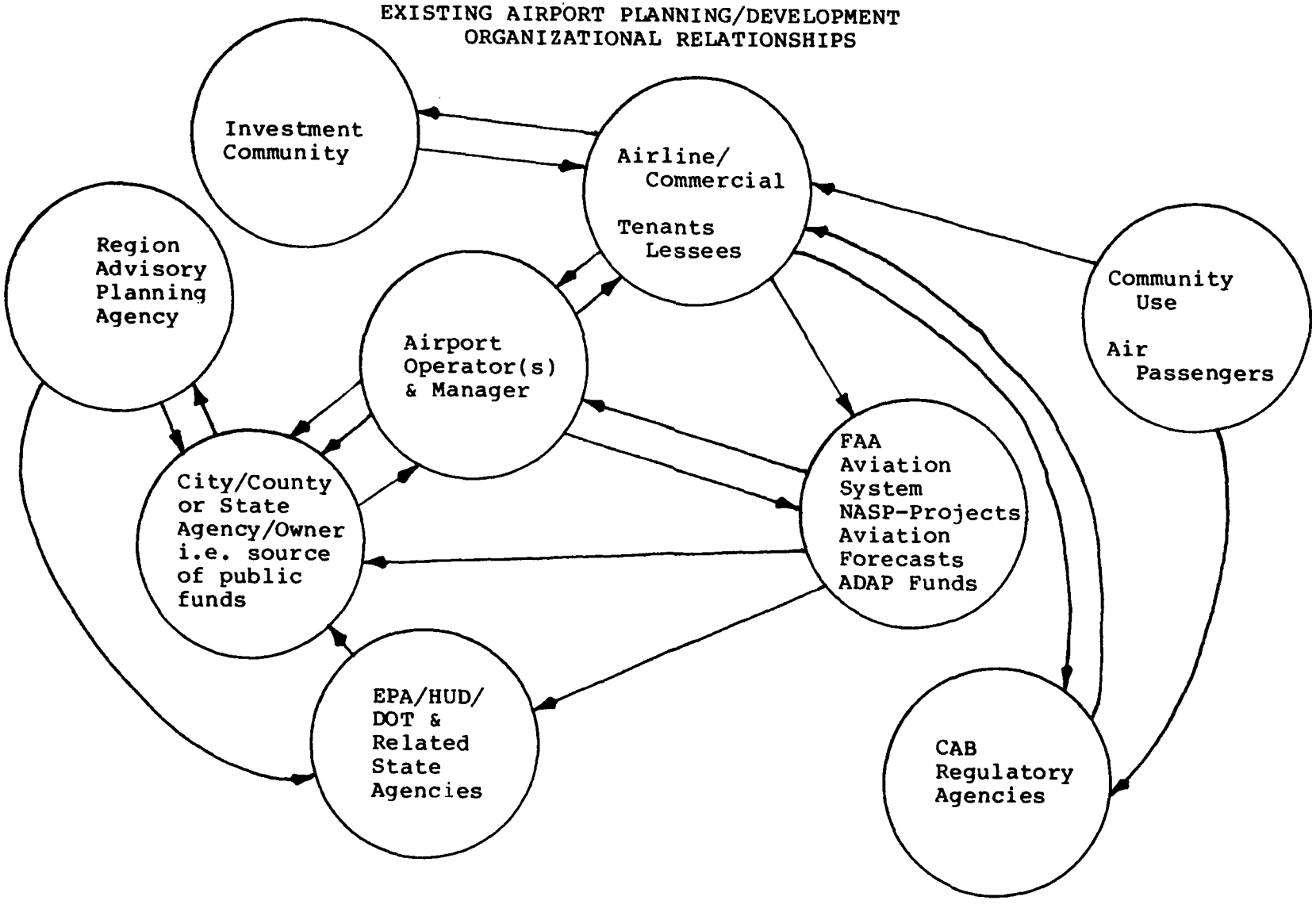
Within the context of SSD, this Chapter would primarily fit in the context of Function Definition. A "Regional Airport Systems and Inventory Assessment Process" might be described in the context of an entity diagram, Exhibit III-1, which represents many of the actors and their general functional roles currently exercised. The following sections elaborate the roles and suggest areas in which the process might be designed to accommodate them. With the creation and use of defined organizational relationships in airport assessment and planning, the process will have a greater chance of success.

B. AIRPORT OPERATORS AND MANAGERS

This group of individuals is the one most likely to receive direct benefit from the process. These individuals, however, now have the least amount of time to devote towards a new process, for which success cannot be guaranteed. They are very busy directors of highly complex operations, which are subject to a large number of "unplanned" events, beyond their control, which impact facilities that are designed to deal with

EXHIBIT III-1

EXISTING AIRPORT PLANNING/DEVELOPMENT
ORGANIZATIONAL RELATIONSHIPS



planned events. To a large extent, many airport operators lease "ground space" or "terminal space" to individual airlines. This changes the operational control of specific facilities, such as gates, from a single manager to a multitude of individual users.

Airport operators manage essentially common facilities designated for use by all corporate or private lessees who pay the proper fees. While the price paid for individual runway operations in terms of landing fees represents a very short term contract, terminal, gate, and parking areas are leased on an annual or multi-year basis.[1/] Charged with maximizing profits or minimizing losses, the airport manager or operator examines monthly or daily receipts to measure utilization. He likely receives very limited statistics on concessionaire or airline operations and probably doesn't have time to analyze them. Such usage information, except perhaps parking, tower, and runway statistics, is probably not available on a daily or hourly basis. An important element to the proposal process includes procedures that airport operators would require in various lease situations. Some of the "usage data elements" were identified in Chapter II, Exhibit II-2 and II-3 and include some of the basic activity measures useful as inputs to models.

C. AIRLINE TERMINAL MANAGERS AND CONCESSIONAIRES

The second group of airport-related staff (Exhibit III-1) who directly involve themselves with facilities management are the commercial operators of the airlines and concessionaires. These individuals are those most intensively involved with day-to-day operational and management problems. They must deal with the "unplanned" events that result in schedule disruptions that appear to amplify specific deficiencies in facilities and available capacity, more than might be suggested by some of the models used to design the facility.

1/ It is for this reason that the General Aviation activity is very difficult to forecast; long term leasing agreements for "visiting" aircraft do not exist. Therefore, many airports have an operating company that manages space for General Aviation on a long term lease basis. The operating company, in turn, sub-leases parking and provides related services.

This group is directly responsible for the day-to-day operation of facilities. Their management procedures yield vast arrays of very detailed data concerning the service rates and through-put statistics of the various terminal sub-system components. If use of landside delay models is to be undertaken to evaluate individual airports, direct inputs from the airline terminal and concessionaire operators regarding service rates and arrival patterns of air passengers would be essential. The concessionaire and airline individuals are also aware of the many management techniques applied to improve capacity, but probably do not relish revealing trade secrets to other competitors.

Individual airline users of terminal space most likely provide to management at their headquarters very specific data on inventory deficiencies, based on current operations. They probably do not, however, have the time to analyze the big picture regarding forecasted growth and estimated future deficiencies. As specific airport operators press for these evaluations and request airline operators for their requirements for longer range facility needs, the airline terminal manager finds himself unable to make long term commitments because he does not have the authority nor the necessary forecast data.

The specific situation regarding non-airline concessionaires is very similar. It appears that the decision-making authority for these individuals, however, may be somewhat stronger at the local level, since many of the operations are treated fairly independently. Additionally, since such services are subjected to many "off-airport" competitive operations, the local managers are the only ones sufficiently aware of conditions that may affect their decisions regarding future inventory needs.

D. AIRCRAFT AND SUPPORT EQUIPMENT MANUFACTURERS AND DESIGNERS

Within the airport complex, the basic suppliers of equipment cannot be ignored. It is reasonable to accept the fact that the aircraft manufacturers can not be realistically included as a direct part of a facilities assessment process. Aircraft development is so very long range that it most logically fits into a long-range planning process. However, many critics of the regional airport systems analysis process have faulted the manufacturers for their failure to develop aircraft that

would better fit with facilities that many believed would relieve the congestion and delay problems.[1/]

The situation with respect to terminal-related facilities and equipment, however, is somewhat closer to the inventory assessment problem. Efforts to alleviate congestion have been reflected in extensive R&D efforts, some of which has been fairly short range in scope. The development of interactive computer reservation systems has had significant impact on improving capacity imbalance between aircraft and the persistent ticketing bottleneck.

With respect to off-airport related access systems to airports, the situation has not been as successful. Since some systems have consistently produced marginal or inadequate profits, the private business incentive for development has been minimal. Concurrently, the factors that lead to assessment of adequacy of such operations are entirely different than private, high-profit, business ventures such as an airline or car rental agency.

1. Airport Designers

A major sub-group are the designers of airport facilities. Within the proposed assessment framework, their role would appear minimal since a relatively long-range planning effort is also associated with major new facilities. However, if designers were to become involved with facility management, they might be able to develop improvements to existing facilities. Another area that deserves more careful attention is the expansion ability of facilities when they are initially designed. This makes low cost, non-capital intensive solutions to increased demand easier to develop at later times.[2/]

1/ This should not be taken to imply that those at fault were the manufacturers alone. Many factors, including basic environmental and marketing considerations, were also related to the problem.

2/ This approach could also have a negative affect on efforts to increase utilization of current facilities. Operators may say they have reached design standards and point to original plans to expand as the only viable solution to capacity problems.

E. URBAN PLANNING AGENCIES

The first non-airport actors with prospective roles in this process includes regional and urban planning authorities. Except in those few cases where metropolitan airport authorities operate all airport regional facilities, these agencies are the only ones with any "big picture" responsibilities to examine airport relationships with the region. Their role in an assessment and planning process could be critical. Traditionally these agencies, however, had a very specific planning, rather than an operational image. Therefore, if such agencies are to take the lead in a management-related process, their behavior will have to be changed.[1/]

As it becomes more evident that assessment of air transportation facilities must be dealt within the context of all modes and facilities, urban planning agencies must assume a stronger role. Urban planning agencies are also best equipped to assess to total door-to-door aspects of air travel.

The urban and metropolitan planning agencies also have two other areas which provide them with credentials that relate well to an assessment process. Recent initiatives towards Transportation Systems Management (TSM) and Environmental Impact Statements (EIS) are related. TSM emphasizes the use of existing facility optimization, and EIS emphasize an assessment approach that attempts to develop relationships among various impacts that are difficult to quantify.

1. Airport, Aviation and Port Authorities

The concept of an airport authority to oversee all aspects of operations, planning and development of aviation facilities has emerged at a few metropolitan planning organizations and several states. These agencies have developed considerable financial and political strength and, to some extent, have overwhelmed the weaker planning organizations involved with urban transportation planning generally. In instances, they have authority over ports that include shipping and passenger movements by

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1/ This, of course, brings forth the long standing discussion of airport authorities versus planning agencies roles. While the Port Authority of New York and New Jersey experience is pointed out in many case studies, it has yet to be determined that it represents the modal situation.

water. They have, however, exercised very little control over inter-city ground transportation (e.g., bus) operations.[1] Although some of these agencies exhibit the organizational potential to accommodate a comprehensive facilities assessment process, their relationship to the non-airport interfaces and basic access considerations is still limited.

At the state levels, aviation authorities have, in several instances, grown out of the basic regulatory functions of agencies charged with overseeing public intrastate transportation. In such cases, the dual roles of regulating and promoting aviation becomes somewhat conflicting.[2]

F. MAJOR FUNCTIONAL STEPS

Before proceeding to Chapter IV, which presents an outline of the assessment process, it is useful to present the basic steps that the process encompasses. Shinn outlined key steps for regional airport planning. These are shown in Exhibit III-2, in the left column, and form the basis for the development of the proposed assessment process. The steps on the right are the components of the proposed process, derived from Shinn's approach.

In developing a process for assessment, the purpose is to identify modifications to Shinn's approach for planning that will increase the understanding of the necessary analytical efforts, re-orient them to an operational and management approach, and identify the organizational concept that should facilitate the assessment process.

1/ An exception here is the NYC area where the limited terminal space has resulted in all inter-city service being operated out of leased Port Authority facilities.

2/ Washington, D.C. has the unique situation of being impacted by one state aviation department (Maryland) that owns an airport and the Division of Aeronautics which still assumes a fairly basic regulatory function, but also administers the ADAP program for Virginia.

EXHIBIT III-2

FUNCTIONAL STEPS - REGIONAL AIRPORT SYSTEMS.

PLANNING PROCESS[1/]	PROPOSED ASSESSMENT PROCESS
Study	
Inventory of Facilities	Inventory of Facilities and Functional Components
Forecasts of Activity	Forecasting of Activity and Monitoring
Analysis of Capacity	Preliminary System Assessment
Planning	
Alternative Identification	Management and Operational Alternatives
Evaluations	Detailed Assessment
Decision and Selection	Detailed Assessment
Operating	
Development of Projects	Demonstration and Refinement
Operation of Facilities	Implementation

1/ Source: Richard D. Shinn, Regional Airport Planning: A Systematic Model, Urban Transportation Program, University of Wisconsin, 1970.

IV. A REGIONAL ASSESSMENT PROCESS

This Chapter discusses the Functional Analysis, as defined by SSD, as it would be expected to be carried out for a modified planning process that will result in an assessment of existing facilities, rather than basic planning for new facilities. The basic structure of Functional Analysis is illustrated in Exhibit IV-1. Each of the steps is discussed in the following sections, using the methodology of SSD to the maximum extent possible.

FUNCTIONAL ANALYSIS

- Define Objectives
- Identify Outputs
- Collect Existing Outputs
- Specify New and Revised Outputs

Exhibit IV-1 - SSD Functional Analysis

A. INVENTORY OF FACILITIES

At first glance, this step seems straightforward. Certainly airport operators are aware of what facilities are available to them, but as noted, these do not constitute the entire system. Traditionally, extensive inventories are not taken until systems studies are initiated, usually as a result of funding made available to local planning agencies for that purpose. In an assessment procedure, the basic objectives of this first step are to: 1) establish a viable classification system for all facilities, 2) establish a regular reporting procedure that avoids costly updating efforts, 3) identify and encourage active participation of all facility owners and operators in the process, and 4) identify other data necessary that are required for analysis of capacity and for other economic analyses that may be needed.

1. Classification

Development of improved landside capacity models has required a further breakdown of various sub-system inventory classifications, that in many cases would not conform to individual record keeping by the airlines and the airport operators.

As illustrated by Exhibits II-2 and II-3 (in Chapter II), these subcomponents and major parameters form the basis for component classification systems. These data do not involve simple area measures but rather emphasize functional units where processing activities takes place. Additional classification of the activities includes the identification of: 1) location, 2) ownership and operational responsibility, 3) space lease, and 4) current versus potential occupancy factors. Additional inventory items would most likely include 1) non-passenger airline overhead space (support of non-functional activity), 2) common areas for passenger flow by type of conveyance (e.g., walking, escalator), 3) non-passenger concessionaire overhead space, and 4) other facilities of an overhead nature.

In a regional context these facilities would further be classified by airport identification and, if necessary, off-airport location identification. The latter is important with respect to any pre-processing that occurs over the phone and at non-airport ticketing locations and terminals. The final set of facilities include off-airport access systems, in terms of vehicles per hour (for example) by type and origin locations. Vehicles privately owned would be excluded unless dedicated to airport access. All facilities that are shared with other purposes such as parking areas, would also be noted with a "shared use availability estimate" if possible.

Other Information - It is also important to establish nonactivity classifications with respect to economic factors. For example, the operational lessee cost or the appropriate annualized cost to recover capital and operating expenses on a unit basis might be useful. Airline cooperation may be difficult to obtain in this instance, but at least the space cost per unit is available to the airport lessee, if the total number of units is known.

Reporting Frequency - Once properly established, the airport functional classification should be routine. The reporting of changes to facilities could be on a project basis, but it is likely that some aspects of the system would require a survey on a regular basis (e.g., six or twelve-month periods). This information could be combined with the activity surveys discussed in the following section.

B. ACTIVITY MONITORING AND FORECASTS

This second step of the process will differ greatly from the forecasting step of the typical planning process. The data required in this step were omitted from the first inventory step, since the type of information required in this portion of the process is "soft" rather than "hard." As demonstrated by the airside capacity models, the requirements for activity monitoring are increased because of the required inputs for level IV simulation techniques (see page II-7). Although the landside models have not reached the same degree of sophistication, it is clear that current activity statistics formally gathered on a continuing basis fall short of the needs indicated by landside analysis. Activity data, therefore, must receive increased attention with respect to passenger activities and patterns they commonly experience in the processing for a flight. It appears that the proposed procedure must establish the framework for adding a monitoring activity which will substitute for the long-range forecast activity typically used in systems planning efforts.

1. Functional Activity Monitoring

All activity data can be classified into three main areas: passenger, flight, and passive support systems. Flight statistics, in terms of arrival and departure schedules and load factors by boarding type are now comprehensively collected by the CAB. Although some elements of these data are on a specific flight basis by month, other statistics are compiled on an airport basis by airline to produce aggregate daily variations.[1/] Other statistics, especially those on the airside, are maintained by the FAA. One item, however, that continues to be elusive is a report of actual flight operations as they relate to the planned schedules for specific airports.

1/ This comment refers to published formats. Naturally, at some level, data for each flight, each day are available, but accessibility to this information is believed impractical. Also, as will become apparent, the present discussions relate to scheduled aviation activity. Unscheduled charter and, more importantly, General Aviation, do not fit well into the proposed assessment procedure based on existing data or terminal congestion models. See Chapter V for additional discussion.

Although these data are mandated in certain formats by the CAB in the form of system schedule compliance reports, it appears in summary format when made available to the public.

Since existing capacity models calculate delay statistics, the only need for observed delay statistics has been for calibration purposes when the models are being tested or developed. The proposed assessment procedure, which will intensify the need for actual characteristics, will most likely not be able to depend entirely on simulation of current activity. The simulations are not sophisticated enough to pinpoint management and short-range operational changes considered relevant to the process, and managers or users will be reluctant to use the simulation outputs.

Therefore, this second step will likely benefit from a monitoring system with data extracted from ongoing programs or initiated as a new activity. A useful reporting cycle appears to be quarterly, since the CAB statistical program is based entirely on such a cycle. A problem with averages calculated on a quarterly basis is the major fluctuations that occur (e.g., for holiday periods). Therefore, sample statistics at selected facilities will have to be increased to measure such variations, which can then be used to adjust average quarterly rate information.

The problem is acute, however, with delay and queuing statistics since it is known that such fluctuations are not easily estimated by adjusting averages. Since many of the acute capacity problems appear during periods of critical demand, it seems that more data on delay and queueing during these times is required at each airport

Airside Data - The most important elements for airside activity monitoring consist of the observed runway service delays, commonly provided as output to the simulation models. Input data involves either inventory or schedule information, already discussed. The last category of airside data for simulation models applies to operational procedures such as those related to taxiing routes and gate operations logic that permits construction of the

airfield network.[1/] These data would be collected in routine inventory, unless alternative procedures are used, which would classify the information as "activity" rather than "inventory," in order to determine when each procedure is in effect.

Specification of the delay information data collection effort for aircraft that is useful for monitoring will require careful determinations of the costs of obtaining the data and its value. Although aggregate delay as noted above is available, it obviously does not pinpoint specific causes.[2/] So many factors affect input assumptions, that sample delay observation data for a few days in a quarter are not sufficient to estimate reliable averages. Also, continuity with the amount of landside delay monitoring data is essential, so that an integrated approach to monitoring total terminal and airside delay can be developed.

Input schedule variances for arrival and departing aircraft caused by another airport or weather factors are outside the domain of the assessment procedure within a given region. Some reliance on the multiple hub network simulation model for this component of delay or probable schedule variance might be necessary. A full description of this model is found in the FAA technical report referenced in footnote 2 below.

Landside Data - With regard to monitoring activity for landside functions, the input data required for level III type simulation models are more demanding since event simulation of individual passengers is not within the scope of these techniques. Establishment of a data collection procedure to measure service rates, arrival rates, etc., appears to be more beneficial to the analyst.

1/ Boarding and debarking passenger operations are reserved for the landside model. Therefore, an interface is required between these data and the gate operations data.

2/ It is noted that this delay is commonly referred to as a "B-delay" which is the net terminal gate departure schedule variance from the OAG as required for CAB reporting. See An Airport Network Flow Simulator, September, 1977, draft report prepared by USDOT, TSC for the FAA Office of Aviator System Plans, pp. 3-6.

As noted, the inventory analysis deliberately omitted the "soft" data with respect to service rates and general passenger characteristics that determine demand for services. While much of these data are collected on a one-time basis and are assumed to experience very little change over time, an improved assessment procedure is expected to develop better information which will detect important trends or changes more quickly. Also, such data will permit improved variation statistics to be determined for periods of time not considered typical.

The basic types of data in this category include 1) traffic mix and speed on roadways, 2) parking in and out movement and duration, 3) rental car, taxi and bus use and storage, 4) curbside duration and vehicle type distributions, and 5) baggage checked and carried out. Other data which require more extensive collection efforts include service rates at critical functional components such as ticketing. Airlines collect these data using traditional management techniques to evaluate personnel performance. However, the airlines may be reluctant to publish such data. Other useful data include perceptions about inconveniences and delays within the terminal, another statistic that specific airline market departments keep very close to their vests.

In the early 1970's many extensive interview efforts were funded by both airline and airport agencies to assist with planning landside facilities. Such efforts, carried out once every five or ten years are not sufficient. Restrictions by the OMB have severely curtailed federal assistance for interview procedures and data. Other attempts with photographic and card time stamp techniques have been attempted and might prove useful for certain elements of service rate and delay measurement.[1/]

Delay and Processing Time - It is noted that a peculiar problem with landside activity evaluation lies within the fact that schedules, which

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1/ These techniques were used for terminal design and systems analysis for a major Canadian airport. Although suggested as a valuable ongoing measure of activity, this one time effort was used to design major new airport facilities.

represent perceived system objectives, do not exist for terminal processing and for access times. There is no basic standard and passengers use experience or informal advice to plan access to the airport. Such a situation precludes development of delay statistics in terms of schedule variance for landside models.

An important element of the proposed assessment procedure is a determination of acceptable processing goals, perhaps independent of current experience. Whether this type of data is collected or not would depend upon the source, but acceptable procedures for their determination should fall upon a cooperative arrangement among regions, indicating a possible specific federal role in the assessment process.

2. Short-Range Forecasts of Activity

The second element of the second assessment step (forecasts) is one which needs specific development of new processes to enable its application to a regional, short-range assessment effort. As previously noted, the current FAA procedures for the 12-year forecasts at the national level are being reviewed with respect to Project Outreach which will make specific attempt to localize the forecasting process and gain better acceptance from the local regions.

The previous section described the activity monitoring aspects of many basic terminal and airside related functions. If facility assessment is to include future conditions, it is obvious that, if similar delay, cost and other factors are estimated, forecasts of these data will also be needed. Since the development of locally acceptable enplanement forecasts for the region is of itself a difficult process, it is unlikely that projections of detailed passenger behavior characteristics, consistent over regions, can be accomplished easily without national coordination.

Definition of Future Time Frames - Since the assessment process is to develop a framework for facilities management for the future in addition to correcting current deficiencies, the establishment of a reasonable forecast period is essential. The current 12-year period is too great and, alternatively, it is unlikely that six-month forecasts will produce significantly different measures that can affect decisions.

Therefore, it seems reasonable that, in addition to the current assessment (present time), the process should develop an analysis for about two years in the future. This time period would allow for the forecasted conditions and the actions developed to affect the management budget. Since no major capital projects are included in the scope of the proposed assessment process, most actions recommended could be accommodated within the planned two-year period.

Passenger Characteristic Trends - It is acknowledged that detailed attempts to statistically forecast the various passenger characteristics (e.g., baggage carried, arrival times, modes of access) are probably not cost effective for two-year periods.

Secondly, it is noted that the concept desired will be to identify desirable changes and make the management decisions that will encourage (but not guarantee) such changes. An example is the amount of carry-on baggage (a passenger characteristic) which the airlines attempted to influence with procedural changes. Several years ago, airline management recognized that airport processing could be significantly improved if more passengers carried on small items of baggage. Therefore, minor changes to the cabin design were made and an advertising campaign begun to change passengers' perceptions of the difficulty with carry-on luggage in the cabin. Another more recent example is the technique of the round-trip boarding pass (including seat reservations) recently instituted by a major airline.

Aircraft and Scheduling Characteristic Trends - The second area of necessary forecasting or scenario building lies with the flights and their schedules, including equipment utilization. This element of the system is one which cannot be forecast independently in each region, and the assessment process must establish some specific system trends on a national basis. The recent efforts of the FAA with respect to the network flow simulator will have to be more fully implemented and understood by the airport regions before being used as input.

Thus far, the network flow simulator has been used for evaluation of current activity. Development of a forecast demand file, even for two years

hence, will be a major undertaking. With the impact of deregulation, it is unlikely that all parties will agree to supply the necessary data that will permit detailed national schedules to be accurately specified for a period two years in the future. Therefore, it will be necessary for someone (for example, FAA) to continue the development of scenarios that will account for likely options. Whether such schedules, by specific airlines, can be developed and agreed upon remains to be determined.

Alternative Approach - A second approach to the scheduling problem is to ignore origins and destinations of aircraft and treat each region independently. In this instance, aircraft are put in to the system without regard to schedule data by origin-destination city or airline. This means that event simulation must construct passenger load statistics and characteristics based on trends identified for specific hours of the day. The critical problem lies in the passenger connect statistics which are dependent upon interrelated scheduling issues. It appears that this approach to schedule forecasting would be undesirable for most of the larger regions and should not be considered for the proposed assessment process.

C. ANALYSES AND PRELIMINARY ASSESSMENT

The third step with Shinn's procedure in planning is likely to be described as a preliminary assessment stage of the proposed process. In other words, the inventory, activity statistics, and short-range scenario forecasts would be processed into an analytical series of efforts designed to indicate performance measures for capacity and delay relationships. Similar in some respects to a deficiency analysis which, in a systems planning effort, identifies system elements that require long-range expansion or replacement, this preliminary assessment provides a means to measure operational and management performance in a more detailed manner.

The most important output of this step is an information report that provides both quantitative and qualitative measures in a reasonable and easy-to-understand format. The format and technique for developing the report must have behind it a national guideline so that similar regional systems can be compared.

While relative delay and cost statistics appear very useful in determining system effectiveness and identifying cost-benefit ratios for decisions of new capital investments, such statistics will not be as effective in an assessment process. A unique approach has been developed with respect to highway systems, using a performance measurement index approach, which might be useful in this case. Numerous measures and conditions are identified and a qualitative and quantitative rating index system developed. In this way, a simple numerical scale (say, 1-5) is used to compare various elements of the system.[1/]

With the development of a report that outputs the analytical results of preliminary assessment, the organization element of the process must be implemented. The local regions will have to establish a "coordination task force" or similar functioning group on facilities assessment to review the outputs and prepare a coordinated evaluation of the completed analyses. The difficulties of obtaining a consensus report are apparent, especially if the organization that prepared the report has not had an understanding and appreciation of the data or the indexing methodology that will be furnished by all participating agencies. Therefore, an extensive assessment procedures manual will probably be needed in advance to train those participating in the process.

D. ALTERNATIVES IDENTIFICATION AND SCREENING

The same organization element that reviews the assessment statistics is likely to direct the development of specific techiques designed to alleviate identified areas of deficiency. It is important that such a process be very open in the initial stages, so that a "wish list" approach will permit all ideas to at least be surfaced. This open approach is difficult to handle in the beginning because everyone views this new procedure as their one chance to put forth what they feel is their unique solution to the problem.

1/ A more commonly understood earlier version of a rating scale can be found in the "traffic level-of-service" which has been a means to decribe highway speed, volume and congestion levels. A more sophisticated "assessment" of our nation's highway was completed in September 1977. See report The Status and Performance of the Nation's Highways: Conditions and Performance, Report to Congress, USDOT printed by Committee on Public Works and Transportation, Washington, 1977 (No. 95-29).

At some point, the organizational task force will have to identify a screening process, where management experts will be needed to identify professional- and business-related (sometime referred to as institutional difficulties) impediments to suggested alternatives. Members of the regional task force might fill such a role, but their viewpoints may come from the organizational elements they represent, and hence, be viewed as tainted. The systems management consultants without specific biases might be more effective. If the development of coordinated recommendations across various regional systems is to be achieved, it is likely that a federal review and screening report would also be necessary.

This national level review should at least encourage on the behalf of the FAA, participation of industry association representatives in the form of a facilities assessment advisory responsibility. The program of the FAA, with respect to forecasting, is an excellent example of such an effort. Upon completion of a formal screening process at this level, the selected options would be returned to the metropolitan organizations for further action.

E. DETAILED ASSESSMENTS AND EVALUATION OF TECHNIQUES

The next step parallels "Evaluations" in the Shinn planning model and likely represents the most difficult procedural aspect of the assessment process. It is possible, after some experience, the regions will develop programmatic themes which seek to achieve certain objectives, and recommend measures which will get on the list. If the recommended measures are not achieved during one assessment period, they can be returned the following year.

In general, this evaluation task is difficult to distinguish from the basic efforts at assessing current procedures, except in the case that no organization exists to implement the approach. Many of the proposed actions will require assessment based on modeling techniques. This means that models capable of simulating the screened alternative must be available. If such is not the case, then the list of potential alternatives must await development of theoretical models, which, in turn, need calibration from a demonstrated example.

Therefore, the proposed process must recognize that some recommended alternatives will best be evaluated by

means of demonstration activity, rather than models. This means that airport and airline management groups must be persuaded to conduct such demonstrations of possible improved management or operations techniques for their facilities, perhaps without any specific indication of their potential benefit.

F. DECISIONS, DEVELOPMENT AND OPERATION

The last three activities within the Shinn concept are not precisely appropriate to the proposed process. They would likely be renamed "Decisions-Implementation-Evaluation", wherein selected management policy decisions that affect short-range facilities operations would be adopted by consensus. This part of the process is self-evaluating, since the implemented procedures would become part of the existing operation that would be monitored by the next inventory and activity data collection cycle.

If those procedures that are selected do not show expected results, they would naturally be eliminated during the next preliminary assessment review cycle.

V. A FRAMEWORK FOR IMPLEMENTATION

The proposed process will not occur as a natural result of the limited discussion and analyses developed in this initial systems planning study. Any procedure which attempts to restructure traditional planning into management assessment will require further detailed design and most likely a carefully documented demonstration and testing activity. There are, however, several issues that appear unresolved and which can be studied with respect to continued development of this proposed process.

A. RELATIONSHIP TO SYSTEMS PLANNING

The intent of an assessment process is to complement the current systems planning activity. As pointed out, there appear to be certain immediate actions that could be taken to further the development of an assessment process. These include:

- Identification of a regional forecasting process, especially for the short-range (up to two years) that will identify significant changes in specific regional airport systems demand, and the characteristics of those changes.

- Clarification of the survey process by which activity statistics on various functional elements of the terminal and landside systems could be collected with safeguards for maintaining the privacy of competitively sensitive information without incurring unacceptable costs in the process.

- Establishment of an organizational design that will serve the assessment process and ensure that existing elements of the airport regional infrastructure will be represented.

Although success in these three areas will go a long way towards achievement of the objectives, the ultimate test of any new process is general implementation through the decision, development and operational stages of systems design. This appears to be one weakness of the system planning aspects of regional airport networks, as pointed out by Shinn. He could not envision a permanent organizational element, with entire responsibility for the implementation. It is likely that

the systems assessment process will not have an identifiable responsible organization for some time to come, without specific efforts to change the situation. Hence, the focus of current efforts should be on enhanced coordination and communication between all affected planning, commercial and governmental organizations in each regional area.

B. RELATIONSHIP TO NON-SCHEDULED AND GENERAL AVIATION

It is apparent that the discussion to this point indicates a pointed focus on scheduled, commercial service of the common carriers. With respect to General Aviation, especially at regional facilities without scheduled service, the proposed assessment process will require substantially new inputs of data which may be very limited on a national or regional basis. These would include:

- Forecast of General Aviation demand, by aircraft type, for specific regions on a scenario basis. Although specific regional bottom-up analyses have been conducted, there has been little attempt to relate the analysis to the potential ownership, use and production levels of the small aircraft types.

- Location and type of General Aviation demand on the groundside for regions on a land-use basis. The specific surveys, conducted for many regions on the commercial side, do not exist for General Aviation business and recreational users. Once again, limited data may exist in some areas and there are national files on pilot and aircraft registration that might be analyzed for some ownership data.

- Demand elasticity for General Aviation requires additional analysis and would suggest the use of attitude and opinion surveys of a fairly sophisticated type, some of which may exist within corporate sensitive files of small aircraft manufacturers.

- Standards or level of service criteria for accessibility of General Aviation within the region to the points of origin-destination requires more data collection efforts as well.

Based on the above consideration, it appears that efforts directed towards some of these problem areas could lead to an improved assessment process for General Aviation facilities. In many cases, the issues of new airports (not considered in the air carrier and commercial assessment) and the renovation of abandoned facilities may become important factors in General Aviation assessment. This could tend to increase the proposed two-year assessment period to three or five years for General Aviation.

The last, and perhaps most important related issue, is the transfer of General Aviation needs out of existing commercial facilities. While the proposed assessment process will define potential benefits from the transfer, no methods appear to exist that will optimize the demand within the region for these relocated General Aviation operations. It appears that any such procedure will have to separate business from recreational usage.

APPENDIX

Structured Systems Design

NICD employs a disciplined, step-by-step procedure for building successful information systems, both manual and automated. This approach, patterned after the Structured Systems Design (SDD) technique of Langston, Kitch and Associates, Inc., ensures that the entire systems process is more rigorous and predictable. We have found that the use of SSD in the design and development of information systems for management has a direct impact on the productivity of our employees, enhances communication between NICD and its clients, provides checkpoints that management can use to monitor the design and development process, and results in systems that produce the information that enables managers to make the decisions and take the actions needed to satisfy organizational objectives.

Structured Systems Design breaks the systems development task into a number of manageable phases. The first phase, requirements definition, involves refinement of the technical approach, definition of the outputs of the tasks to be performed, agreed upon by the user. In the subsequent design phase the results of the requirements definition phase are logically manipulated to define the system components and sub-systems required to achieve the already defined outputs. Then the designed processes are developed, tested and evaluated in the construction phase. The constructed components are then subjected to final comprehensive system testing and training of system operators (users) is done, if required, in the utilization phase.

The requirements definition phase of the design and development process is especially critical to the proposed effort. A great deal of emphasis should be put upon utilizing a systematic method to develop the output specifications. The basic steps in defining these systems requirements are as follows:

- Functional Definition;
- Functional Analysis;
- Functional Design.

The requirements definition phase includes initial meetings with the user management to establish the scope and objectives of the project. These meetings are crucial because 1) they establish the rationale for making changes to the existing environments; 2) they establish the commitment of

user management to follow through on the recommendations developed and 3) they identify the true users of the system.[1/]

Initially, data will be gathered in order to understand or conceptualize the organizational operations and needs for information. The first objective will be to determine key functions and rank the functions in relation to one another.

Next, the analyst develops a list of objectives for each functional step. These objectives are best stated in measurable, i.e. output-oriented, form. Outputs that are required to support the functions are then identified. With the list of required outputs defined, the analyst contacts the user to collect the existing outputs which match up with the defined (required) outputs. When an output is not present or does not exactly match the functional requirements, the designer must develop the appropriate output.

The functional design activity is primarily concerned with identifying and relating the various cycles that occur in the system i.e. regularities in the system operations. For example, some information will be reported on a daily basis, some on a weekly, monthly or yearly basis. The data must be grouped in a way that facilitates combination into reports that can satisfy all cyclical requirements.

The end of the requirements definition phase involves providing a summary of the system requirements for management. The requirements report will serve as the starting point for the design phase.

The SSD methodology distinguishes between two main elements of the design phase, the logical design and the physical design. The logical design provides the relationships that are characteristics of the application whereas the physical design reflects modifications required for implementation in a particular organization subject to various constraints.

The logical design is key to the determination of the specific data items required to produce the outputs, the identification of how to print them out, how to update them and how to get them into the system in the first place. It is here that unnecessary or redundant data elements are eliminated and the presence of required items is verified.

1/ Structured Systems Design, Langston, Kitch & Associates, Inc., p. IV.8.

The physical design refers to the packaging or modularization and the development of the final set of systems bluepints.

The design phase will be vital to the proposed effort in that this is the part of the effort that will provide the EDP Planning and Management Division with descriptions of the approach to be used in streamlining the information collection process and the method of reducing data into a usable form.

The remaining phases of construction and utilization will be employed to translate the design into a workable system, including the development of the procedures that have been defined, preparation of forms that are required and completion of documentation needed to understand, implement and use the system that is developed.

ANNOTATED BIBLIOGRAPHY

Nearly 100 references concerning all aspects of aviation and regional planning were reviewed during the course of the study. This annotated bibliography highlights those reports, articles, books and other materials considered of direct relevance to the study objective.

Two subject areas are used to organize the references; some references may fit in both, but are presented in the primary subject area without cross-reference. The areas are: Systems Planning and Forecasting, and Airport Capacity and Delay Analysis.

SYSTEMS PLANNING AND FORECASTING

National Level

This area deals primarily with broad based policy initiatives for aviation. The role of the FAA and the various technical publications of this agency are referenced in this section.

deNeufville, Richard, Airport Systems Planning, The MIT Press, 1976

This represents a recent, but very generalized documentation, of the approach towards aviation systems development. The document deals with "massive uncertainty" and average errors in forecasting rather than shedding any light on the author's opinion of aviation's future. With the benefit of the energy and environmental impacts on aviation, the narrative demonstrates a keen awareness of the issues at hand.

Two other aspects of the book indicate deNeufville's bias, the emphasis on ground access and regional issues concerning airport development; the technological issues of vehicle development and sophisticated air traffic control systems are set aside.

Shriver & Seifert, Air Transportation 1975 and Beyond: A Systems Approach, The MIT Press, 1968

As documentation of a 1967 International Workshop on Transportation in the aviation sector, this report served as a basic reference in the early 70's. However, some elements of the forecasts, especially with respect to technology and allocation of efforts to the Vietnam War has resulted in many variances between this prediction and the actual events of the 1970's.

Six major subdivisions of analysis are discussed: (1) socio-economics, (2) air vehicle, (3) air traffic control, (4) airports and terminals, (5) mixed-mode access and (6) governmental process. As might be expected, the report is optimistic and not impacted by the subsequent environmental and energy crisis of the 70's. However, as a basic reference document, the publication serves as a key element in any development of the systems approach to aviation planning.

USDOT-FAA, Aviation Futures to the Year 2000, February 1977

A methodology for development of the current scenarios for aviation and their relationship to the National Aviation System is discussed in this summary report. Detailed backup reports were still awaiting release by the FAA when this bibliography was prepared. Once again, at the national level, the study, while useful as a starting point, does not go into sufficient detail for specific regional assessment of short term requirements.

USDOT-NASA, Technology Assessment of Future Intercity Passenger Transportation Systems, March 1976, Volumes 1-7 (Volume 1 examined only)

This large study effort, which involved multi-mode issues of long distance travel between cities, utilizes effectively the concept of scenario development at the national level to examine technological potential of various alternatives. Since the study deals primarily with longer range issues, only the summary document was examined in depth.

The 13-month study, looking towards the year 2000, used impact assessment techniques through workshops involving 30 members of a select group of transportation experts.

Regional Level

Certain references obtained during the research effort directed the analysis at the metropolitan and regional levels (i.e., state, metropolitan area or other geographical grouping of airports) are discussed below.

Brown, John F., Environmental Aspects of Airport System Planning, Transportation Engineering Journal of ASCE, Vol. 96, TE4, November 1970, pp. 543-559

This paper briefly reviews the environmental considerations in systems planning, but by not restricting himself to any specific area, the author is unable to give extensive treatment to the subject. He displays some market statistics for both Air Carrier and General Aviation in various specific study regions and then emphasizes that "accessibility" will be an important determinant of air travel potential.

USDOT-FAA, The Airport - Its Influence on the Community Economy, 1967

As prepared by the Systems Planning Division in 1967, this report documented the impacts of airport development from the one perspective of the local economy. The survey of facilities emphasized General Aviation airports in communities of between 10-85 thousand persons and used various local and Census data sources to measure economic relationships. The document was not found specifically useful in the proposed assessment process.

USDOT-FAA, Establishment of New Major Public Airports in the United States, August 1977

This policy report develops the framework for long-range airport needs at 24 major regions based upon the range of possible alternative aviation developments. Since the current study emphasized the short-range aspects of assessment, this report was not utilized directly.

USDOT-FAA, Planning the Metropolitan Airport System, May 1970

This basic document, prepared in cooperation with the Airport Operations Council, HUD and FHWA, sets forth many of the issues that involve planning of airport(s) at the metropolitan level. The guidelines, as published, were primarily directed at regions with urban populations of 500,000 or more and/or those which generate over 250,000 scheduled airline enplaned passengers.

Three primary sections, dealing with (1) organization and funding, (2) planning process, and (3) implementation and continuing planning, provide a fairly comprehensive overview. Specific details and case study experiences are not outlined. Therefore, the document leaves to individual local judgment many aspects of the detailed planning procedure. The document contains some elements of emphasis which may be out-of-date for the late 1970's.

Regional Level - Accessibility Issues

Since the assessment of facilities, within a region, relates heavily to the relative accessibility of origins/destinations and the ground travel modes available, airport access issues were considered important to the assessment process.

Baker, Robert F. and Raymond M. Wilmotte, Technology and Decisions in Airport Access, 1970

This report documents the special study review of the Washington, D.C. airport accessibility issues and the efforts to improve the optimal allocation of demand among the three competitive airports. The effort was one of the first which attempted to use "level of service" concept for ground access time between the airports and local origination-destination points. The study, conducted in 1969, used the 1968 survey of passengers and computed ground travel times to all three airports, weighted by the number of passengers. (Note: A unique follow-up to this study, using 1974 origin-destination data, attempts to incorporate flight schedule (i.e., Level of Service) parameters to the choice of airports.)

The expected travel times were then applied to occupational groups and forecasted into the future to determine the level of impact among specific airport user groups. Finally, a summary of research needs was developed.

The most recent and comprehensive review of landside issues was developed by the Transportation Research Board (TRB) Specialty conference and documented by it in Special Report 159. Since this document contains over 50 individual presentations, those which relate to the facility assessment issues are noted below.

Heathington, Kenneth W. and Don H. Jones, Identification of Levels of Service and Capacity of Airport Landside Elements. A workshop identified seven major issues to be addressed: (1 and 2) Users and quantitative dimensions of level of service, (3 and 4) Level of service measures and values, (5) Technological alternatives, (6) Airport tenants, and (7) Forecasting level-of-service factors through further research. Extensively developed summary tables identify pertinent facilities and types of measures that might be used. Summary conclusions are drawn and research recommendations made.

A resource paper for the same workshop, by Majorie Brink and Don Maddison, also addresses the level of service measurement issues and concludes with 12 statements concerning the overall landside.

Kivett, Hanan A., Alternative Methods for Providing Landside Capacity at Existing Sites. This paper documents conclusions of another workshop that focused on the use of existing facilities through summary of primary and secondary impact relationships between various functional elements; problem classifications are developed.

McCabe, Lawrence and Thomas Carbarry, Simulation Methods for Airport Facilities, identifies computer techniques for various approaches to simulating terminal and landside activities. The input/output characteristics of time-oriented queueing model, the most common approach, are discussed, but it was noted that most applications lack validation. The report recommmends that an "extensive data collection effort should be undertaken to provide a data base for further model comparisons and validation."

Negrette, Arthur J., Airport Landside and Off-Airport Inteaction, one of the source papers for another workshop, identifies the relationship of demand and supply for non-airport owned facilities and illustrates project funding mechanisms and parking alternatives available to improve capacity.

Other papers and workshop documentations were reviewed in this report; those selected provide only a representative set. The total document represents one of the most comprehensive treatments of landside capacity problems of the airport systems.

AIRPORT CAPACITY AND DELAY ANALYSIS

A major category of technical reports, primarily produced by the FAA, centers around the issue of technical analysis of airport capacity and performance. This portion of the bibliography is not designed to provide the entire scope of FAA efforts, but rather to give an impression of how the efforts might relate to an assessment process for metropolitan airport systems.

Ball, Carl T., Model User's Manual for Airfield Capacity, Final Report, FAA-RD-76-128, Books 1 and 2, USDOT, prepared by Office of Systems Research and Development Service, November 1976

This document provides user-oriented material describing the application of computer capacity and delay models as developed and adopted by the FAA. The two basic types, analytic and simulation, are described for basic component areas: (1) runways, (2) taxiways and (3) gates. The simulation approach uses a Monte Carlo-critical event technique and requires substantial input data whereas the basic capacity models reflect the computer application of reading nomographs and curves developed by previous studies.

Bellantoni, Juan F. and Joseph A. Tanne, The Airport Network Flow Simulator, draft Final Report, September 1977, USDOT-TSC, prepared for the Office of Aviation System Plans, unnumbered.

This report documents the characteristics of the impact of A-delay, B-delay[1/] and total delay, excepting slack time (which is input), gate arrival lateness and the effect of missed connections. Utilizing an existing 665 airport schedule, the report documents test simulation of the OAG schedule for 1976 in the Census states. The outputs for selected airports were then compared to two trunk line and local service carrier airframe itineraries actually carried out.

This technical report does not discuss policy or potential application of the simulation for future scenarios, which is documented in other reports.

1/ Delays in aircraft operations such as in landing, take-off, etc. are A-delays; delays in meeting arrival and departure schedules are termed B-delays.

Bellantoni, Juan F. et al., The Airport Performance Model-Extensions, Validation and Applications, Report No. SS-213-U4-15, USDOT-TSC, September 1976

This report documents the single airport simulation model design to be used in conjunction with ANFS to provide total costs and investment strategies for airport systems. The report follows-up on an earlier Interim report, FAA-ASP-75-5, The Airport Performance Model, which was also reviewed in the course of the present study.

Designed as an operational tool for local airports, this model exhibits potential of becoming an excellent device for an assessment process, assuming that several of the proposed enhancements are incorporated without complications. The model does not incorporate queueing theory for landside activity.

Fromme, William A. and William A. Swan, Airport Quotas and Peak Hour Pricing: Analysis of Airport Network Impacts, Final Report, FAA-AVP-77-12, USDOT prepared by Office of Aviation Policy, undated

This report follows a companion study on Theory and Practice (AVP-77-5) completed in May 1976, and examines through network calculations the quantitative estimates of reduced system delays and the relationship with complementary system improvements envisioned by UG3RD. The advantage of this network analysis relates to ripple effects that occur with respect to schedule impacts that implementation by one airport may create.

Approximately 70 percent of the commercial schedule, using 23 of the nations largest airports, were represented in MIT's fleet assignment model (used for several FAA studies) which produces OAG type time of day traffic profiles. Referred to as FA-4 (Fleet Assignment Process), the simulation proceeds to develop an airline schedule by using a passenger demand in eight different profile groups. A delay calculation is then developed using enplanement and city-pair forecasts as developed by FAA concurrent research. (Note: This study used a 1975-1990 growth factor of 2.07 and 3.02 for the year 2000). Procedures as documented in the Model User's Manual for Airfield Capacity, (annotated above) are then implemented to calculate impacts of the proposed policy alternative. The policy was a three stage procedure: (1) price out non-commercial, (2) peak-price congested hours in commercial market and (3) impose quota if (1) and (2) were not successful.

Fromme, William R. and John M. Rodgers, Policy Analysis of the Upgraded Third Generation Air Traffic Control System, Final Report FAA-AVP-77-3, USDOT prepared by Office of Aviation Policy, January 1977.

This policy document provides a detailed evaluation of UG3RD and complementary schedule options for cost and delay impacts on the future air traffic control system. Essentially a summary document for many technical reports, completed earlier, the report identifies cost-benefit ratios for five system configurations and three policy strategies. Over 102 technical references are provided in the appendix to this report.

Although this report served to identify possible scheduling and satellite policy options for the future system, the actual results are not applicable to the present study if the future is determined to be short range, when most elements of UG3RD will not be implemented. Additionally, the report is limited with respect to interface with terminal and groundside models and deals primarily with runway and airspace delay minimization.

USDOT, An Econometric Analysis of Enroute and Terminal Air Traffic Control, June 1976, FAA-AVP-77-1

This report deals primarily with a new major investment strategy for UG3RD system being considered by FAA. Since this report deals with long range strategy for air traffic control, generally beyond the scope of urban regional systems for airports, it was used in this study only as informational document.